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Research Article **Araştırma Makalesi**

Zooplankton of Deriner Dam Lake (Artvin-Türkiye)

Deriner Baraj Gölü Zooplanktonu (Artvin-Türkiye)

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Abstract: This study was carried out seasonally at 8 stations determined in Deriner Dam Lake between 2020 and 2021. In order to determine the seasonal zooplankton taxon diversity and richness at the determined stations, the samples were collected in the surface water with a plankton net with a mesh size of 55 µm. In the distribution of zooplankton, more taxon was recorded in autumn and spring seasons compared to other seasons in terms of both the number of species and the number of individuals. In addition to presence of Rotifera species in high numbers in general, *Polyarthra dolichoptera* is the most common species seen in all seasons. *Asplanchna sieboldi* from Rotifera, *Acanhopdiaptomus denticornis* from Copepoda, and *Daphnia cucullata* from Cladocera were the dominant species of their groups.

Keywords
- Rotifera
- Cladocera
- Copepoda

Özet: Bu çalışma, 2020-2021 yılları arasında Deriner Baraj Gölü'nde belirlenen 8 istasyonda mevsimsel olarak yapılmıştır. Belirlenen istasyonlarda mevsimsel zooplankton takson çeşitliliği ve zenginliğini belirlemek amacıyla 55 mikron göz açıklığında plankton ağı ile yüzey sularından örnekler toplanmıştır. Zooplankton dağılımında tür sayısı açısından sonbahar ve ilkbahar mevsimlerinde diğer mevsimlere göre daha fazla takson kaydedilmiştir. Rotifera türlerinin sayısı fazla olmakla birlikte her mevsim görülen en yaygın tür *Polyarthra dolichoptera* olmuştur. Rotifera'dan *Asplanchna sieboldi*, Copepoda'dan *Acanhopdiaptomus denticornis* ve Cladocera'dan *Daphnia cucullata* gruplarının baskın türleriydi.

Anahtar kelimeler
- Rotifera
- Cladocera
- Copepoda

1. INTRODUCTION

All water bodies form various biotopes according to their physical, chemical, and biological properties. Organisms in an ecosystem determine the productivity of that ecosystem. Therefore, to understand the efficiency of an aquatic environment the biomass in that environment should be well known (Sen, 1987). Zooplankton, which is the second link of the food chain in freshwater ecosystems, is the food source of invertebrates, fish, and sometimes birds and some species are indicators of water quality, pollution, and eutrophication due to their sensitivity to environmental changes. In addition, the fact that some genera and species show the feature of determining the water quality, pollution, and eutrophication status of the waters in which they are found increases their importance even more. For this reason, it is reported that zooplankton studies to be carried out in wetlands gain importance (Berzins & Pejler, 1987; Mikschi, 1989; Güher & Kırgız, 1992). Zooplankton includes several taxa, most of which are microscopic, such as protists, rotifers, copepods, and cladocerans (de Vargas, et al. 2015). Numerous studies have provided consistent and important insight that zooplankton taxa are rapid responders to many environmental stressors, such as hydrological changes, climate changes, and water pollution from anthropogenic activity (Duggan et al., 2001; Pawlowski, 2016).

Zooplankton contributes to the biodiversity of aquatic ecosystems. Therefore, it is necessary to evaluate the factors affecting the distribution of zooplankton (Hemlata, et al., 2013; Mimouni et al.,

2018) because zooplankton are widely accepted and irreplaceable bioindicators in the ecological protection and management of aquatic ecosystems (Xiong, et al., 2019). While most of them are fed by filtering the water, they also act as cleaning the water column (Bekleyen & Tas, 2006).

The fact that Rotifera species are more numerous than other zooplankton groups in freshwater systems is due to the high level of nutrients, high reproductive success of Rotifera species, and the ability of rotifers to be easily transported to aquatic environments by factors such as birds, wind and current (Herzig, 1987)

Since there is no similar research on Deriner Dam Lake, all of the data obtained are new data to be added to the literature.

2. MATERIAL AND METHOD

Deriner Dam Lake is the constructed on Çoruh River in Artvin for generating energy. The dam is located in the Eastern Black Sea Region and is 5 km upstream of the bridge on the state highway connecting Artvin city center to Erzurum city center (Figure 1). The dam lake is the highest in Turkey in its class, and the 3rd in Europe, and the 6th in the world, with a body height of 249 m from the foundation. The dam lake is also Turkey's 7th largest Hydroelectric Power Plant (URL, 2023)

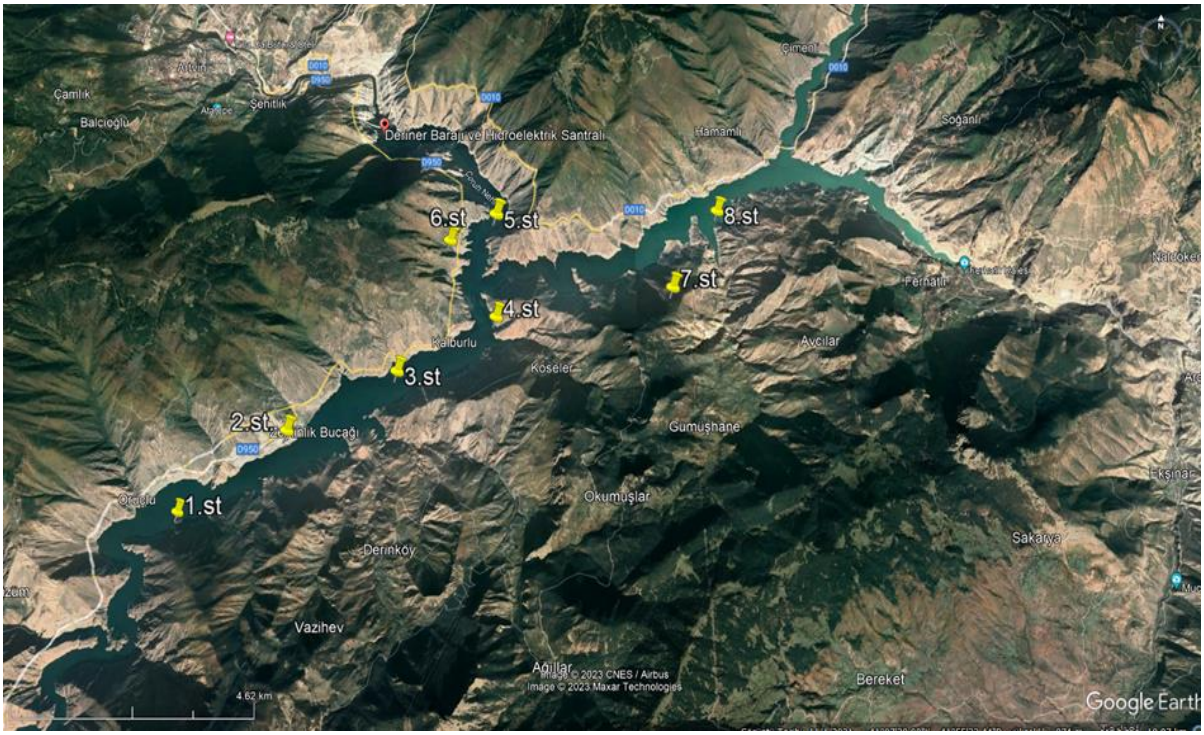

Figure 1. Sampling stations

Table 1. The coordinates of the sampling satations.

Stations	Coordinates	
1	41° 6.000'N	41° 49.476'E
2	41° 6.548'N	41° 51.152'E
3	41° 7.230'N	41° 52.360'E
4	41° 7.627'N	41° 53.610'E
5	41° 9.027'N	41° 53.553'E
6	41° 8.424'N	41° 53.971'E
7	41° 8.791'N	41° 56.278'E
8	41° 9.559'N	41° 57.963'E

This study were carried out seasonally at 8 stations determined in Deriner Dam Lake between 2020 and 2021. Samples were taken 5 times from each station with a 55 µ mesh size of plankton net placed in 250 mL jars, brought to the laboratory as soon as possible, and fixed stored in 4% formaldehyde. Zooplanktonic organisms in water samples were examined with inverted and research microscopes, and species were identified and related sources (Edmondson, 1959; Grasse, 1965; Kolisko, 1974; Koste, 1978a, 1978b; Dumont & De. Ridder, 1987; Negrea, 1983; Einsle, 1996), the species identification of Rotifera, Cladocera and Copepoda was made. In addition, physical measurements were made in the sampling area with a YSI brand EXO 2 model device (probe). Temperature, pH, conductivity, and dissolved oxygen, were measured instantaneously in situ.

3. RESULTS

During the research, a total of 25 zooplankton species were identified. Of these species, 13 species of Rotifera (52%), 10 species of Cladocera (40%) and 2 species belong to the Copepoda (8%) group. A total of 6 families were recorded among the rotifers. The family Synchaetidae was the most abundant with 4 species, followed by Asplanchidae and Gastropodidae with 3 species, Brachinoide, Dicranophoridae and Notommatidae one species. Ten families were recorded among Cladocera. Daphnidae was the richest family with 5 species. Among the 2 families of Copepoda, Cyclopoidae and Diaptomidae.

Table 2. Species observed during the spring sampling period at the 2020

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Rotifera								
Ascomorpha saltans Bartsch,1870	+	+				+		
Asplanchna girodi de Guerne, 1888			+	+				+
Asplanchna priodonta Gosse, 1850		+	+					+
Synchaeta pectinata Ehrenberg, 1832					+			+
Gastropus stylifer (Imhof, 1891)							+	
Keratella tecta (Gosse, 1851)	+							+
Polyarthra dolichoptera Idelson,1925	+			+	+	+	+	
Polyarthra remata Skorikov, 1896	+							
Polyarthra vulgaris Carlin, 1943					+			
Cladocera								
Daphnia cucullata Sars, 1862	+	+	+	+	+	+	+	+
Daphnia longispina O.F.Müller, 1875	+	+	+			+		
Daphnia magna (Straus, 1820)	+							+
Leptodora kindtii (Focke, 1844)		+					+	
Sida crystallina (O.F.Müller, 1776*)*					+			
Copepoda								
Acanthopdiaptomus denticornis (Wierzejski, 1887)		+	+	+	+	+	+	
Cyclops vicinus Uljanin, 1875	+	+	+	+	+		+	+
Total taxa	8	7	6	5	7	5	6	7

Table 3. Species observed during the summer sampling period at the 2020

TAXA	1	2	3	4	5	6	7	8
Rotifera								
Asplanchna priodonta Gosse, 1850	+	+	+	+	+	+	+	+
Asplanchna sieboldi (Leydig, 1854)		+		+			+	+
Cephalodella catellina (Müller, 1786)				+				
Polyarthra dolichoptera Idelson,1925		+				+		
Cladocera								
Bosmina longirostris (O.F.Müller, 1785)			+					
Daphnia cucullata Sars, 1862	+	+	+	+	+	+	+	
Sida crystalina (O.F.Müller, 1776)	+	+	+		+	+	+	+
Copepoda								
Acanthopdiaptomus denticornis (Wierzejski, 1887)	+		+	+	+	+	+	+
Cyclops vicinus Uljanin, 1875		+				+		
Total taxa	4	6	5	5	4	6	5	4

Table 4. Species observed during the autumn sampling period at the 2020

TAXA	1	2	3	4	5	6	7	8
Rotifera								
Ascomorpha ovalis (Bergendahl, 1892)	+							
Asplanchna priodonta Gosse, 1850	+	+	+	+				+
Asplanchna sieboldi (Leydig, 1854)	+	+	+		+	+	+	+
Dicranophorus sp.			+					
Polyarthra dolichoptera Idelson,1925		+	+	+				
Cladocera								
Coronatella rectangula (Sars, 1862)				+				
Bosmina longirostris (O.F.Müller, 1785)		+	+	+	+			+
Ceriodapnia reticulata (Jurine, 1820)				+				
Daphnia cucullata Sars, 1862	+	+	+	+	+	+	+	+
Daphnia longispina O.F.Müller, 1875	+	+	+	+	+	+		
Daphnia magna (Straus, 1820)					+			
Daphnia obtusa Kurz, 1874					+	+		
Leptodora kindtii (Focke, 1844)				+			+	+
Polyphemus pediculus (Linnaéus, 1761)	+							
Sida crystallina (O.F.Müller, 1776)			+		+	+	+	
Copepoda								
Acanthopdiaptomus denticornis (Wierzejski, 1887)	+	+	+	+	+	+	+	+
Cyclops vicinus Uljanin, 1875			+		+			
Total taxa	7	7	10	9	9	6	5	6

Table 5. Species observed during the winter sampling period at the 2021

TAXA	1	2	3	4	5	6	7	8
Rotifera								
Asplanchna sieboldi (Leydig, 1854)	+	+						
Gastropus stylifer (Imhof, 1891)		+	+			+	+	
Polyarthra dolichoptera Idelson,1925			+					
Synchaeta pectinata Ehrenberg, 1832							+	
Cladocera								
Bosmina longirostris O.F.Müller, 1785)				+				
Ceriodaphnia reticulata (Jurine, 1820)	+							
Daphnia cucullata Sars, 1862	+							
Daphnia longispina O.F.Müller, 1875				+			+	+
Daphnia obtusa Kurz, 1874								+
Copepoda								
Acanthopdiaptomus denticornis (Wierzejski, 1887)	+	+	+	+	+	+	+	+
Cyclops vicinus Uljanin, 1875	+	+	+		+	+	+	+
Total taxa	5	4	4	3	2	3	5	4

In spring, the most observed Rotifera species were *Polyarthra dolichoptera* (recorded in 5 stations). For Cladocera, *Daphnia cucullat*a (8 stations). On the other hand, *Cyclops vicinu*s had the largest distribution range (7 stations), inside the copepods (Table 2). In summer, for the Rotifera, *Asplanchna priodonta* recorded in total 8 stations. *Daphnia cucullata* and *Sida crystallina* were recorded in 7 stations. Besides, From Copepoda that *Acanthopdiaptomus denticornis* had the largest distribution range (7 stations). In Autumn, *Asplanchna sieboldi* was the most observed species (7 sations), from cladocera *Daphnia cucullata* was found at all stations (8 stations), while *Acanthopdiaptomus denticornis* from copepoda was found at all stations. In winter, *Gastropus stylifer* from Rotifera was observed at 4 stations, *Daphnia longispina* from cladocera at 3 stations, and *A. denticornis* from copepoda at all stations (Table 5).

Table 6. Surface water physicochemical values

	Temp. (°C)	pH	E.C (µS/cm)	D.O (mg/L)
		Spring		
Ave.	22.04	8.40	222.60	10.65
Min.	19.70	8.28	188.90	10.32
Max.	23.86	8.48	243.00	10.99
		Summer		
Ave.	23.90	8.48	467.81	8.32
Min.	22.95	8.33	455.20	8.04
Max.	25.04	8.68	478.80	8.76
		Autumn		
Ave.	20.26	8.08	546.35	8.08
Min.	20.03	7.99	528.90	7.59
Max.	20.65	8.15	569.60	8.41
		Winter		
Ave.	11.14	8.40	492.20	9.55
Min.	10.70	8.24	427.80	9.30
Max.	11.45	8.54	534.60	9.76

During the sampling studies carried out at 8 stations in Deriner Dam Lake, water quality parameters were monitored seasonally. Water temperature, pH, dissolved oxygen, electrical conductivity measurements were made *in situ*. It has been determined that the temperature of the dam lake varies between 10.70 and 25.04°C.While the pH varied between 7.99 and 8.68, the average value was measured as 8.33. The conductivity values detected between 569.60- 188.90 µS/cm. In the

examination carried out in the research area, dissolved oxygen was measured between 7.59-10.99 mg/L (Table 6).

4. DISCUSSION

A total of 25 zooplankton species were identified. Of these species, 13 species of Rotifera (52%), 10 species of Cladocera (40%), and 2 species belong to the Copepoda (8%) group. The fact that the number of Rotifera species in freshwater systems is higher than the other zooplankton groups causes the nutrient level to be high, the high reproductive success of Rotifera species, and the rotifers can easily enter aquatic environments with factors such as birds, wind, and currents. In the zooplankton distribution of Deriner Dam Lake, more zooplankton were recorded in autumn and spring than in other seasons in terms of the number of species. Yigit (2006), in her study in Kesikköprü Dam Lake, determined that rotifers are more numerous in spring and autumn than in other seasons. Similar to Korkmaz (2000) recorded that the total amount of zooplankton was highest in spring and autumn in Beytepe Pond. Tuna &Ustaoğlu (2016) observed the same findings in a study at Kemer Dam Lake. Similar zooplankton profiles were also recorded in Göksu (Bekleyen, 2003), Kepektaş (Saler, 2009), Karakaya (Saler et al., 2010), Kalecik (Bulut & Saler, 2013), Beyhan (Bulut & Saler, 2014), Ozluce (Ipek Alış & Saler, 2014) Uzuncayir reservoirs (Saler et al., 2014). Hancağız (Saler &Alış, 2014), Kığı (Bulut, 2018), and Çat (Saler et al., 2019), In these lakes, Rotifera took the first place in terms of the number of zooplankton taxa. In Tercan, Kuzgun, and Demirdöven Dam Lakes, an increase was observed in the distribution of zooplankton in the spring, on the other hand, it was recorded as the period when the zooplankton abundance was the lowest in the winter (Saler & Selamoğlu, 2020).

Some rotifer species and cyclopoid copepods can be used as indicators of the trophic level of lakes and reservoirs. The composition, richness, and abundance of these species vary according to various limnological variables associated with trophic conditions. Rotifera species are generally more concentrated in eutrophic lakes, while Copepoda species are mostly found in oligotrophic lakes (Herzig, 1987). Although the number of Rotifera species is high in Deriner Dam Lake, the least number of species belongs to the Copepoda group. In Rotifera, which is generally the dominant group of eutrophic lakes, only *Keratella tecta* species belonging to the Keratella genus were recorded in the spring season. Therefore, it would not be correct to comment on the trophic status of the lake by looking at the rotifer species recorded in the lake (Kolisko, 1974).

Acanthodiaptomus denticornis, the most abundant species in Deriner Dam Lake, is a large calanoid copepod. It is a tolerant species found in both freshwater lakes and small nutrient-rich ponds. This species is found in 20% of the water bodies from which zooplankton is sampled. It is especially abundant in high-altitude lakes (Yang & Min, 2020). In the dam lake, this species has been recorded in more than 90% of the samplings at the stations.

Sida crystallina (Cladocera: Sididae, O.F. Müller 1776) is a typical epiphytic cladoceran species occurring in temperate and tropical waters. Compared with other cladoceran species, *S. crystallina* occurs at relatively high water temperatures (approximately 21 to 22 °C; Kotov & Boikova 1998) and is prevalent in temperate zones during summer (Balayla & Moss, 2003). In this study, the presence of *S. crystallina* supports these studies in warm seasons. *L. kindtii* is a predator whose diet contains mostly cladocerans (Abrusan, 2003). This species, which is a predator, was seen in the spring and autumn seasons. *Polyphemus pediculus* is a size-dependent predator (Young &Taylor, 1988). This species was identified in autumn.

Temperature is one of the most important environmental parameters controlling the biological and chemical events in aquatic areas, and with the increase in temperature, the biological activity in the aquatic area increases, and biochemical reactions accelerate and affect the reproduction, nutrition, and metabolic activities of aquatic organisms (Tas et al., 2011. Therefore, in the spring months when the temperature suddenly increases, the zooplankton density increases, and the ecosystem productivity increases. In our study, based on these data, it was determined that the water temperature was between 10.70-25.04°C and showed differences according to the seasons.

Water pH can also have an impact on zooplankton; low pH causes reduced zooplankton abundance, as well as decreased biodiversity and the loss of some species (Ivanova & Kazantseva, 2006; Yamada

& Ikeda, 1999), whereas alkaline conditions that accompany high primary production favors the growth and abundance of zooplankton (Bednarz et al., 2002; Mustapha, 2009).

The conductivity in the dam lake was measured in the range of 188.90-569.60 µs/cm. The electrical conductivity value is an indicator of the ion content of the reservoir water. The values specified in the protocol on fisheries standards and the protection of surface water resources against pollution are between 150-500 µS/cm (Uslu & Türkman, 1987).

One of the most used parameters in determining water quality is the amount of dissolved oxygen in the water. In order to sustain aquatic life under aerobic conditions in freshwater ecosystems, the minimum dissolved oxygen value of the water should not be less than 5.0 mg/L (Gülle, 1999). The value of dissolved oxygen found in our study was reported to be suitable for zooplankton life.

5. CONCLUSION

The zooplankton species found during the study are important as they are the first record for Deriner Dam Lake. Most of the species recorded in this study are considered cosmopolitan. Temperature, pH, electrical conductivity, and dissolved oxygen are among the values that aquatic organisms can live. This study will form the basis for future studies in these dam lakes and also for Turkiye's biodiversity gains.

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ETHICAL STATEMENT

The authors declare that no experimental animals were used in the study.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest

AUTHOR CONTRIBUTIONS

Planning the study: H.B., D.F., S.S. Literature: H.B., S.S. Methodology: H.B., D.F., S.S., Performing the experiment: S.S., D.F., Data analysis: H.B., D.F. Manuscript writing: H.B., S.S. Supervision: D.F., All authors approved the final draft.

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